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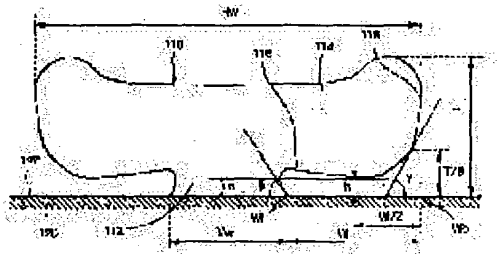
(54) RESIST PATTERN OF T-SHAPED SECTION AND ITS PRODUCTION AS WELL AS MAGNETO-RESISTIVE THIN-FILM ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide resist patterns having T-shaped sections of a good contrast in order to lower the defective article rate at the time of forming the electrode patterns, etc., of a magneto-resistive thin-film element.
SOLUTION: The homogeneous resist patterns are formed by using a positive type resist for image reversal and the sections 110 thereof have the T-shape. The min. angle formed by the tangent at the bottom edge 116 of the cross bar part and a substrate surface 122 is defined as α and the spacing between the lower edge 116 in the cross bar part and the substrate surface at the intermediate of the intersected point Wo of the perpendicular down from the outermost edge 118 of the cross bar apart and the substrate surface and the contact point Wi of the side edge 112 of a vertical bar part and the substrate surface is defined as h, then α and h in an h-α graph exist in the quadrilateral passing A:α=0° , h=0.01μm, B:α=20° , h=0.01μm, C:α=20° , h=0.2μm, D:α=0° , h=0.3μm.



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* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1] It is characterized by providing the following. It is a resist pattern homogeneous on the real target formed using the resist agent by which the negative working-ized agent was added by the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide, and the picture inverting function was given to it. a cross-section configuration It is T configuration equipped with the vertical bar portion which is prolonged upwards from a substrate front face and constitutes the vertical bar section of T form substantially, and the horizontal bar portion which is horizontally prolonged where an interval is kept to a substrate front face succeeding this vertical bar portion, and constitutes the horizontal bar section of T form substantially, and is the aforementioned cross-section configuration. The intersection Wo of the perpendicular and substrate front face which set the minimum value of the angles on the tangent of the bottom edge of a horizontal bar portion, and the front face of a substrate to make to alpha, and were taken down from the horizontal bar partial outermost side edge to the substrate front face. When the interval of the bottom edge of a horizontal bar portion and substrate front face in the mid-position with the point Wi that the vertical bar partial side edge and substrate front face by the side of the aforementioned outermost side edge touch is set to h, Within the limits surrounded with the quadrilateral which connected with this order four points alpha and whose h are A:alpha = 0 degree and h= 0.3 micrometers in the h-alpha graph 0 degree and h= 0.01 micrometers (on the side.) B:alpha = 20 degrees and h= 0.01 micrometers C:alpha = 20 degrees and h= 0.2 micrometers D:alpha=
[Claim 2] It sets in the aforementioned h-alpha graph, and alpha and h are A:alpha =0 degree and h= 0.01 micrometers. X:alpha = 5 degrees and h= 0.01 micrometers Y:alpha = 5 degrees and h= 0.15 micrometers Z:alpha = resist pattern of the T section of the claim 1 which exists within limits (a side top is included) surrounded with the quadrilateral which connected with this order four points which are 0 degree and h= 0.15 micrometers.
[Claim 3] It sets in the aforementioned h-alpha graph, and alpha and h are A:alpha =0 degree and h= 0.01 micrometers. X:alpha = 5 degrees and h= 0.01 micrometers G:alpha = 5 degrees and h= 0.1 micrometers H:alpha = resist pattern of the T section of the claim 1 which exists within limits (a side top is included) surrounded with the quadrilateral which connected with this order four points which are 0 degree and h= 0.1 micrometers.
[Claim 4] The resist pattern of one T section of the claims 1-3 which are W= 0.03-3 micrometers when distance with the point Wi that the intersection Wo of the perpendicular and substrate front face which were taken down from the horizontal bar partial outermost side edge to the substrate front face, and the vertical bar partial side edge and substrate front face by the side of the aforementioned outermost side edge touch is set to W.
[Claim 5] The resist pattern of one T section of the claims 1-4 which are Hw=0.1-7micrometers when the maximum width of the aforementioned horizontal bar portion is set to Hw.
[Claim 6] The resist pattern of the T section of the claim 5 which is Vw/Hw=0.1-0.995 when the aforementioned vertical bar portion sets width of face of the field adjacent to the substrate front face to Vw.
[Claim 7] The resist pattern of one T section of the claims 1-6 with which a front face is formed on the front face of the substrate which consists of a metallic material or ceramic material.
[Claim 8] The resist agent by which the negative working-ized agent was added by the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide, and the picture inverting function was given to it is used. In the bottom of the condition from which the resist pattern of a reverse trapezoidal shape is obtained for a cross section in case a resist pattern is manufactured by patterning process in which it has each stage of formation of a resist paint film, exposure, reversal BEKU, and development in this order By adding at least one sort of condition change chosen from reduction of resist paint film thickness, reduction of light exposure, low-temperature-izing of reversal baking temperature, shortening of reversal BEKU time, elevated-temperature-izing of developer temperature, and extension of a developing time The manufacture method of the resist pattern of the T section whose manufacture of the resist pattern which is T configuration a cross section enables.

[Claim 9] the time of displaying as plus the direction which considers as minus the direction which approaches a substrate on the basis of a resist paint film front face in the focal position at the time of exposing to a resist paint film, and keeps away from a substrate -- the aforementioned focal position -1-+10 micrometers it is -- the manufacture method of the resist pattern of the T section of a claim 8

[Claim 10] The manufacture method of the resist pattern of the T section of the claims 8 or 9 which perform reversal BEKU for [for / 30 seconds / -] 13 minutes at the temperature of 100-123 degrees C.

[Claim 11] The manufacture method of the resist pattern of one T section of the claims 8-10 which manufacture the resist pattern of one T section of the claims 1-7.

[Claim 12] The magnetoresistance-effect type thin film in which at least one layer in the electrode layer for a magnetoresistance-effect film and magnetoresistance-effect films is formed by the lift-off method using the resist pattern of one T section of the claims 1-7 as resist covering.

[Claim 13] The magnetoresistance-effect type thin film in which at least one layer of the electrode layer for a magnetoresistance-effect film and magnetoresistance-effect films and a shield film is formed by the milling patterning method using the resist pattern of one T section of the claims 1-7 as resist covering.

[Claim 14] The magnetoresistance-effect type thin film in which the continuation film of a magnetoresistance-effect film and the electrode layer for magnetoresistance-effect films is formed by the method of using together the milling patterning method and the lift-off method, using the resist pattern of one T section of the claims 1-7 as resist covering.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the resist pattern of the T section and its manufacture method, and the magnetoresistance-effect type thin film in which at least one layer of the electrode layer for a magnetoresistance-effect film and magnetoresistance-effect films and a shield film is formed using the aforementioned resist pattern.
[0002]
[Description of the Prior Art] Conventionally, the method shown below is learned as the formation method of a resist pattern that a cross-section configuration shows a reverse trapezoid or T form.
[0003] (A) It is the method (refer to JP,61-136226,A) of exposing by the usual method and performing patterning, except making light exposure into lowness for the (Method a) method (i) negative resist which forms the pattern which a cross section is a reverse trapezoid and consists of single resists and which uses the negative resist of one layer by ultraviolet-rays exposure.
[0004] (b) How to make the substrate side of a resist the degree of low temperature rather than a front-face side at the time of the method (i) prebaking which uses the positive resist of one layer, and a postbake. About prebaking, the postbake is indicated by JP,54-72678,A at JP,3-101218,A, respectively.
(ii) How to expose by far ultraviolet rays to the resist film for electron rays of a positive type (refer to JP,1-50423,A).
(iii) How to hold in a high vacuum before [after applying a novolak type resist] exposure (refer to JP,3-257817,A).
(iv) How (refer to JP,5-37275,A) to perform ultraviolet-rays exposure from the front reverse side both sides of the resist applied on the transparent substrate.
(v) How to produce the pattern section and the non-pattern section, once, form a protective coat on these, remove the non-pattern section using this protective coat, and shorten the exposure time, when exposing a positive resist with an electron ray beam (refer to JP,51-147261,A).
(vi) How to make a predetermined value the ultraviolet-absorption coefficient of the polymer of a resist itself, or the addition of the cross linking agent to a resist (refer to JP,58-16527,A).
(vii) How to apply on a substrate the photoresist colored with the color which absorbs exposure light, dip subsequently to a solvent, and control the coloring concentration distribution of the thickness direction in a resist (refer to JP,1-284851,A).
[0005] (c) It is Hoechst as a method (i) resist which uses the positive resist (one layer) which gave the picture inverting function. By using the resist of ****** using shrine AZ5200E series The {AZ5200E series catalog with which it is known that the pattern which has the cross section of a reverse trapezoid configuration will be producible, M. BORUZEN, "the submicron lithography technology by picture reversal of a positive-type photoresist", 6 Electronic material, 1 (1986), It reaches. M.Spac et al and "Mechanism and lithographic evaluation of image reversal in AZ5214 photoresist.", Proc.of conference on photopolymers principle processing and materials., Ellenville (1985)}. This resist gives a picture inverting function by adding negative working-ized agents, such as a basic amine, to the positive resist which is the mixture of alkali fusibility phenol resin and naphthoquinonediazide.
[0006] (B) The way a cross section exposes a negative resist using two kinds of electric charge beams from which the T method (i) range which uses (Method a) one-layer resist which forms the pattern of type differs (refer to JP,62-105423,A). However, in this official report, the cross-section [of T characters]-like pattern is changing with the contraction after carrying out a rinse and drying to the cross-section rectangle-like pattern.
[0007] (b) How (refer to JP,62-141548,A) to perform double exposure by the suitable exposure of exposure by the predetermined exposure corresponding to the predetermined pattern configuration, and exposure by the predetermined exposure to this pattern configuration core to the positive resist of (Method i) two-layer structure which uses a two-

layer resist.
(ii) How to expose a predetermined pattern simultaneously to the vertical two-layer electron beam resist by which the laminating was carried out through the detached core (refer to JP,63-55208,B).
(iii) How to form in the 1st photoresist film front face the facies which has resistance in the development of the 2nd photoresist film (refer to JP,2-65139,A).
(iv) How to prepare the resist film of two-layer structure and make pattern opening width of face on the upper surface of a lower layer resist larger than the opening width of face under the upper resist (refer to JP,2-208934,A).
[0008] as mentioned above -- although the various conventional examples were explained, even if the many are the cases where the cross-section configuration of a resist pattern is a reverse trapezoid, and is accepted to be the T section -- that it is necessary to use two layers of resists or to carry out exposure twice **** -- etc. -- it carried out, formation was very difficult, and it was that by which actuality is not accompanied
[0009] By the way, as a method of forming an electrode pattern etc. on a substrate, the lift-off method, the milling patterning methods, and these using [together] methods exist. The outline of these methods and the reason nil why the resist configuration of a cross-section T typeface is desirable are explained below.
[0010] An example of the pattern formation method using the milling patterning method ion milling is shown in drawing 2 . By this method, a milling-ed film is first formed all over a substrate. Subsequently, a resist layer is formed in the front face of a milling-ed film, and patterning of this is carried out, it considers as resist covering, and ion milling of the milling-ed film is carried out by using this resist covering as a mask. Then, resist covering is removed by the dissolution, ashing, etc. by the organic solvent, and the milling-ed film by which patterning was carried out is obtained.

[0011] When the cross-section configuration of resist covering is a rectangle or a reverse trapezoid like the conventional example, in case a milling-ed film is **********ed using the ion milling method, the particle which dispersed from the milling-ed film adheres to a resist covering side attachment wall, grows, and arrives at even the front face of a milling-ed film, namely, may carry out the reattachment to a milling-ed film (refer to drawing 3). For this reason, when resist covering was removed, it might be said that the portion which carried out the reattachment will remain in the front face of a milling-ed film as a minute salient.
[0012] If the height for a neck is enough since the resist covering lower part is narrow in T form although the scattering particle from a milling-ed film adheres to resist covering in the case of etching even when the cross-section configuration of resist covering is T form, it will not grow up so that an adhesion layer may follow the front face of a milling-ed film (refer to drawing 4). For this reason, the milling-ed film by which patterning was carried out good is obtained, without also removing an adhesion layer with resist covering and a reattachment portion remaining in the front face of a milling-ed film, when resist covering is removed.
[0013] Although the lift-off method, next the lift-off method are explained, the case where the film by which patterning was carried out by the lift-off method is formed on the above-mentioned milling-ed film by which patterning was carried out is explained here. This method is used for a series of processes which form a lead layer on for example, a magnetoresistance-effect film.
[0014] An example of this lift-off method is shown in drawing 5 . By the method shown in drawing 5 , after preparing the substrate which has first the milling-ed film by which patterning was carried out on a front face and forming a resist layer on this substrate, resist covering which is illustrated is formed by carrying out patterning. Subsequently, patterning-ed films, such as a metal and ceramics, are formed all over a substrate front face including resist covering. Subsequently, in the organic solvent which can dissolve a resist, the field which exists on resist covering among patterning-ed films is removed with resist covering, and a patterning film is obtained.
[0015] In this process, an organic solvent must fully permeate during resist covering. However, when the cross-section configuration of resist covering is a reverse trapezoid like the conventional example, in case a patterning-ed film is formed, as shown in drawing 6 , a patterning-ed film will adhere also to a resist covering side attachment wall, and will cover resist covering. For this reason, an organic solvent cannot fully permeate during resist covering, and might be unable to remove resist covering.
[0016] On the other hand, when the cross-section configuration of resist covering is T form, although membranes are formed by the upper surface and the side attachment wall of a resist covering eaves portion in case a patterning-ed film will be formed, if the height for a neck (under an eaves portion) of the resist covering lower part is under the thickness of a patterning-ed film as shown in drawing 7 , since the amount of neck becomes the shade of an eaves portion, it is not formed by the amount of neck. Therefore, the film which formed membranes does not cover resist covering completely, an organic solvent permeates during resist covering from a part for a neck, and the film formed on it with resist covering can be removed certainly.
[0017] An example of the method of using together the using [together] method ** of the milling patterning method

and the lift-off method is shown in drawing 8 . By this method, first, after forming a milling-ed film all over a substrate front face, a resist layer is formed, patterning of this resist layer is carried out, and it considers as resist covering. In the example of illustration, the cross section forms resist covering of a reverse trapezoid. Subsequently, without removing resist covering, after carrying out patterning of the milling-ed film by the ion milling method, the resist covering is used as resist covering of the lift-off method as it is, and a metal, ceramics, etc. are formed. Subsequently, films which exist on it with resist covering, such as a metal and ceramics, are removed by dissolving resist covering by the organic solvent. Of such a process, the continuation film of the milling-ed film in which patterning was carried out by the ion milling method, and films by which patterning was carried out by the lift-off method, such as a metal and ceramics, is formed in a substrate front face.

[0018] In this using [together] method, when the cross-section configuration of resist covering is a rectangle or a reverse trapezoid like the conventional example, a minute salient may remain in the boundary line of the film in which patterning was carried out by the ion milling method of the aforementioned continuation film by the reason explained previously, and the film by which patterning was carried out by the lift-off method. Moreover, resist covering may be unable to be removed.

[0019] When the cross-section configuration of resist covering is T form, the good continuation film of the film by which patterning was carried out by the ion milling method, and the film by which patterning was carried out by the lift-off method can be obtained without generating the above problems for the reason explained previously. [0020] [Problem(s) to be Solved by the Invention] in a Prior art, the T section in which good contrast is when it is going to form the resist pattern of the T section, although the resist pattern of a reverse trapezoid [cross section] was obtained was not obtained by 1 layer resist for example, in the one-layer resist, as shown in drawing 17 -20, only the resist pattern of a reverse trapezoid [cross section] is obtained from the AZ5200E catalog any -- Although drawing 17 is an excimer laser, drawing 18 is i line, drawing 19 is g line and the exposure light in the case of patterning is a wide band light in which drawing 20 contains i line, g line, and h line, even when which exposure light is used, the cross section has not become in T form.

[0021] on the other hand, when it was going to form the resist pattern to which the cross section is carrying out T form by the two-layer resist by the Prior art, mixing whose time and effort is very between resists in this top and a resist interface took place, and T form with good contrast was not obtained

[0022] Thus, when the resist pattern of the T section of good contrast was not obtained, therefore the electrode pattern for magnetoresistance-effect films of a magnetoresistance-effect type thin film etc. was formed using the resist pattern of this conventional T section in the former, the electrode material remained in many cases into portions other than a required electrode pattern, and the rate of a defective of a product was high.

[0023] In order to stop very low the rate of a defective at the time of forming the electrode pattern of a magnetoresistance-effect type thin film etc., the purpose of this invention is offering the resist pattern which has the T section of good contrast, and is offering the magnetoresistance-effect type thin film in which the electrode pattern's etc. was formed using this resist pattern.

[0024]

[Means for Solving the Problem] Such a purpose is attained by one composition of following the (1) - (14).

(1) It is a homogeneous resist pattern substantially. it was formed using the resist agent by which the negative working-ized agent was added by the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide, and the picture inverting function was given to it -- a cross-section configuration The vertical bar portion which is prolonged upwards from a substrate front face and constitutes the vertical bar section of T form substantially, Are T configuration equipped with the horizontal bar portion which is horizontally prolonged where an interval is kept to a substrate front face succeeding this vertical bar portion, and constitutes the horizontal bar section of T form substantially, and it sets in the aforementioned cross-section configuration. The intersection Wo of the perpendicular and substrate front face which set the minimum value of the angles on the tangent of the horizontal bar partial margo inferior, and the front face of a substrate to make to alpha, and were taken down from the horizontal bar partial outermost side edge to the substrate front face, When the interval of the horizontal bar partial margo inferior and substrate front face in the mid-position with the point Wi that the vertical bar partial side edge and substrate front face by the side of the aforementioned outermost side edge touch is set to h, an h-alpha graph -- setting -- alpha and h -- A:alpha= 0 degree and h= 0.01 micrometers B:alpha = 20 degrees and h= 0.01 micrometers C:alpha = 20 degrees and h= 0.2 micrometers D:alpha= Resist pattern of the T section which exists within limits (a side top is included) surrounded with the quadrilateral which connected four points (0 degree and h= 0.3 micrometers) with this order.

(2) Set in the aforementioned h-alpha graph and alpha and h are A:alpha =0 degree and h= 0.01 micrometers. X:alpha = 5 degrees and h= 0.01 micrometers Y:alpha = 5 degrees and h= 0.15 micrometers Z:alpha = resist pattern of the T section of the above (1) which exists within limits (a side top is included) surrounded with the quadrilateral which

connected with this order four points which are 0 degree and h= 0.15 micrometers.
(3) Set in the aforementioned h-alpha graph and alpha and h are A:alpha =0 degree and h= 0.01 micrometers. X:alpha = 5 degrees and h= 0.01 micrometers G:alpha = 5 degrees and h= 0.1 micrometers H:alpha = resist pattern of the T section of the above (1) which exists within limits (a side top is included) surrounded with the quadrilateral which connected with this order four points which are 0 degree and h= 0.1 micrometers.
(4) width -- a bar -- a portion -- the outermost -- a side edge -- from -- a substrate -- a front face -- having taken down -- a perpendicular -- a substrate -- a front face -- an intersection -- Wo -- the above -- the outermost -- a side edge -- a side -- length -- a bar -- a portion -- a side edge -- a substrate -- a front face -- touching -- a point -- Wi -- distance -- W -- ** -- having carried out -- the time -- W -- = -- 0.03 -- - -- three --
(5) The resist pattern of one T section of above-mentioned (1) - (4) which is Hw=0.1-7micrometer when the maximum width of the aforementioned horizontal bar portion is set to Hw.
(6) The resist pattern of the T section of the above (5) which is Vw/Hw=0.1-0.995 when the aforementioned vertical bar portion sets width of face of the field adjacent to the substrate front face to Vw.
(7) The resist pattern of one T section of above-mentioned (1) - (6) with which a front face is formed on the front face of the substrate which consists of a metallic material or ceramic material.
(8) Use the resist agent by which the negative working-ized agent was added by the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide, and the picture inverting function was given to it. In the bottom of the condition from which the resist pattern of a reverse trapezoidal shape is obtained for a cross section in case a resist pattern is manufactured by patterning process in which it has each stage of formation of a resist paint film, exposure, reversal BEKU, and development in this order By adding at least one sort of condition change chosen from reduction of resist paint film thickness, reduction of light exposure, low-temperature-izing of reversal baking temperature, shortening of reversal BEKU time, elevated-temperature-izing of developer temperature, and extension of a developing time The manufacture method of the resist pattern of the T section whose manufacture of the resist pattern which is T configuration a cross section enables.
(9) the time of displaying as plus the direction which considers as minus the direction which approaches a substrate on the basis of a resist paint film front face in the focal position at the time of exposing to a resist paint film, and keeps away from a substrate -- the aforementioned focal position -1-+10 micrometers it is -- the manufacture method of the resist pattern of the T section the above (8)
(10) The above (8) which performs reversal BEKU for [for / 30 seconds / -] 13 minutes at the temperature of 100-123 degrees C, or the manufacture method of the resist pattern of the T section of (9).
(11) The manufacture method of the resist pattern of one T section of above-mentioned (1) above-mentioned [which manufactures the resist pattern of one T section of - (7)] (8) - (10).
(12) The above (1) Magnetoresistance-effect type thin film in which at least one layer in the electrode layer for a magnetoresistance-effect film and magnetoresistance-effect films is formed by the lift-off method using the resist pattern of one T section of - (7) as resist covering.
(13) The above (1) Magnetoresistance-effect type thin film in which at least one layer of the electrode layer for a magnetoresistance-effect film and magnetoresistance-effect films and a shield film is formed by the milling patterning method using the resist pattern of one T section of - (7) as resist covering.
(14) The above (1) Magnetoresistance-effect type thin film in which the continuation film of a magnetoresistance-effect film and the electrode layer for magnetoresistance-effect films is formed by the method of using together the milling patterning method and the lift-off method, using the resist pattern of one T section of - (7) as resist covering.
[0025]
[Function] The resist pattern of the T section was realized by using an one-layer resist, i.e., a resist with the homogeneous whole, and controlling by this invention, as patterning conditions were described above.
[0026] Since the T section configuration of high contrast which the whole is formed by the homogeneous resist and has Above alpha and h in predetermined within the limits is made, the resist pattern of the T section of this invention can reduce the rate of a defective remarkably, when the electrode pattern of a magnetoresistance-effect type thin film etc. is formed using this, and when it is best, it can realize 100% of rate of an excellent article.
[0027] In addition, although there is no example which has formed the pattern of the T section by one picture exposure before basic application (Japanese Patent Application No. No. 209950 [seven to]) of this application, using the resist of one layer, the resist pattern of the T section is indicated by the 25-30th page of the reference "IEEE TRANSACTIONS ON MAGNETICS, VOL.32 NO.1, JANUARY 1996" published after application of basic application of this application. By this reference, it has measured whether what a cross-section configuration, the amount of the reattachment object which remains after a lift off, etc. are influenced by change of light exposure or the BEKU (equivalent to reversal BEKU in this specification) temperature after exposure, and the result is shown in Table

3. However, the absolute value of light exposure or baking temperature is not indicated by this reference, and the kind of used resist is not indicated, either. For the resist pattern indicated in Table 3 of this reference, it is formed using the wide band light of i line cut as an exposure light, and full [of a cross section] (W) is 3.6 micrometers. The height (H) of the vertical bar section of T form is 0.2 micrometers above. It is above. In addition, the kind of exposure light was judged from the aligner currently used by this reference.

[0028] By this reference, Si wafer is used as a substrate. Moreover, although the scanning-electron-microscope photograph of the cross section of a substrate and a resist pattern is indicated by drawing 4 of this reference, as long as this drawing 4 is seen, it is thought that the resist pattern is directly formed on Si wafer front face. However, according to the experiment of this invention persons, it was impossible to have formed the resist pattern of the T section in Si wafer front face directly. As for the resist used by this invention, bad [an adhesive property with Si wafer] as the reason for concrete, since a touch area with a substrate produces a detailed resist pattern narrowly using i line preferably by this invention, the resist pattern of the T section can consider that a resist pattern tends to exfoliate from Si wafer. For this reason, while controlling patterning conditions by this invention as mentioned above, it is Si and SiO2. By using the substrate which has the front face of an except, formation of a detailed T section resist pattern is enabled. On the other hand, the detailed T section resist pattern which used i line for the above-mentioned reference is not indicated.

[0029]

[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained in detail.

[0030] Since the resist pattern of this invention is what carried out patterning, was formed by method which mentions a picture reversal correspondence positive resist later, and carried out patterning of the one-layer resist, it is substantially homogeneous.

[0031] When patterning is carried out in this specification according to a series of processes of a resist agent and picture exposure -> heating {following and reversal BEKU (RB)} -> uniform exposure (henceforth, flood exposure) -> development that the picture reversal correspondence positive resist made the positive resist the base resin, the negative working-ized agent was added by this and the picture inverting function was given to it, a picture exposure portion remains like a negative resist.

[0032] In this invention, the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide is made into a base resin, and the picture reversal correspondence positive resist of composition of having added the negative working-ized agent to this is used.

[0033] The above-mentioned alkali fusibility phenol resin is a phenol formaldehyde novolak resin, a cresol formaldehyde novolak resin, etc.

[0034] The above-mentioned naphthoquinonediazide compound increases the solubility over an alkali solution by activity light irradiation with the compound which has at least one naphthoquinonediazide machine. The compound of various structures is known as such a compound, and especially a kind of a hydroxyl compound and o-benzo ****** have desirable ester of o-naphthoquinonediazide sulfonic acid. As these compounds, it is a 2 and 2'-dihydroxydiphenyl-screw. - [A naphthoquinone -1, a 2-diazido-5-sulfonate], A 2 and 2 '4, 4'-tetrapod hydroxy diphenyl-tetrapod [a naphthoquinone -1 and a 2-diazido-5-sulfonate], 2, 3, 4-TORIOKISHI benzophenone-screw - There are [a naphthoquinone -1, a 2-diazido-5-sulfonate], etc. The ester of the acetone indicated by especially JP,43-25403,B, the polyhydroxy phenyl obtained by the condensation polymerization of pyrogallol, a naphthoquinone -1, and a 2-diazido-5-sulfonic acid etc. can be mentioned.

[0035] As the above-mentioned negative working-ized agent, an aromatic hydrocarbon, 1-hydroxyethyl-2-alkyl imidazoline, or a shellac etc. which has an amine and a hydroxyl group is mentioned.

[0036] As an amine of the above-mentioned negative working-ized agent, a dialkyl amine, alkylamine, the secondary amine that has a hydroxyalkyl machine or a tertiary amine (henceforth a hydroxy alkylamine), a dialkylamino aromatic hydrocarbon, and annular polyamine can be raised, for example. As an example of a dialkyl amine, diamylamine, diheptylamine, There is a JIDESHIRU amine etc. as an example of alkylamine Tributylamine, A triamylamine, trihexyl amine, and a TORIISO amyl amine As an example of a hydroxy alkylamine, a diethanolamine, N-methylethanol amine, N-methyldiethanolamine, dipropanolamine, and a triethanolamine Diethylaniline and a dipropyl aniline can be raised as an example of a dialkylamino aromatic hydrocarbon, and a hexamethylenetetramine can be raised as an example of annular polyamine, respectively.

[0037] Moreover, the aromatic hydrocarbon which has one or more hydroxyl groups in which esterification or etherification is possible as an aromatic hydrocarbon which has a hydroxyl group can be used. There are the resin and hydroxybenzene compound which have the benzene ring which has a hydroxyl group as an example of the aromatic hydrocarbon which has a hydroxyl group, and a phenol formaldehyde novolak resin and a cresol formaldehyde novolak resin can be raised as an example of a resin of having the benzene ring which has a hydroxyl group. Considering

pyrogallol, phloroglucinol, 2, and 2-screw (4-hydroxyphenyl) propane as an example of 1-hydronalium SHIKIECHIRU-2-alkyl imidazoline, the carbon atomic number of an alkyl group is mentioned as an example of a hydroxybenzene compound, and the compounds and those mixture to 7-17 are mentioned.

[0038] A compound desirable as these negative working-ized agent has a triethanolamine, N-methylethanol amine, N-MECHIRUJI enol amine, diethylaniline, a hexamethylenetetramine, tributylamine, a TORIISO amyl amine, a metacresol formaldehyde resin, a shellac, 1-hydroxyethyl-2-alkyl imidazoline, etc.

[0039] The amount of the above-mentioned negative working-ized agent used receives the above-mentioned resist base-resin 100 weight section. In the case of an amine, preferably The range of the about 0.005 weight section to the about 1 weight section, In the case of the aromatic hydrocarbon or shellac which has the range of the about 0.01 weight section to the about 0.3 weight section, and a hydroxyl group more preferably, preferably The range of the about 0.005 weight section to the about 10 weight section, more -- desirable -- the case of the range of the about 0.01 weight section to the about 3 weight section, and 1-hydroxyl ethyl-2-alkyl imidazoline -- desirable -- the range of the about 0.005 weight section to the about 0.1 weight section -- it is the range of the about 0.01 weight section to the about 0.07 weight section more preferably

[0040] The various additives other than the above-mentioned component can be added to the photopolymer constituent used for this invention. For example, since picture intensity is raised, as a binder, the resin which can be mixed with the aforementioned component to homogeneity, for example, a styrene maleic anhydride copolymer, a styrene-acrylic-acid copolymer, a methacrylic-acid-methyl-methacrylate copolymer, etc. can also be added.

[0041] Detailed composition of this kind of resist is indicated by JP,55-32088,B, the British patent No. 844039 specification, the U.S. Pat. No. 4104070 specification, etc.

[0042] As shown in drawing 1 , the cross-section configuration 110 of the resist pattern of this invention is a T configuration equipped with the vertical bar portion 112 which is prolonged upwards from the front face 122 of a substrate 120, and constitutes the vertical bar section of T form substantially, and the horizontal bar portion 114 which is horizontally prolonged where an interval is kept to a substrate front face succeeding this vertical bar portion, and constitutes the horizontal bar section of T form substantially.

[0043] The intersection Wo of the perpendicular and the substrate front face 122 which set the minimum value of the angles on the tangent of the horizontal bar partial margo inferior 116, and the front face 122 of a substrate to make to alpha, and were taken down from the horizontal bar partial outermost side edge 118 to the substrate front face in the cross-section configuration shown in drawing 1 , When the interval of the horizontal bar partial margo inferior 116 and the substrate front face 122 in the mid-position (the distance from Wo is W/2) with the point Wi (the distance of Wo and Wi is W) that vertical bar partial 112 side edge and the substrate front face 122 by the side of the aforementioned outermost side edge 118 touch is set to h, As shown in the h-alpha graph of drawing 9 , alpha and h are A:alpha=. 0 degree, h= 0.01 micrometers B:alpha = 20 degrees and h= 0.01 micrometers C:alpha = [20 degrees,] h= 0.2 micrometers D:alpha= It exists within limits (a side top is included) surrounded with the quadrilateral which connected four points (0 degree and h= 0.3 micrometers) to this order. preferably A:alpha =0 degree and h= 0.01 micrometers X:alpha =5 degree and h= 0.01 micrometers Y:alpha = 5 degrees and h= 0.15 micrometers Z:alpha = It exists within limits (a side top is included) surrounded with the quadrilateral which connected four points (0 degree and h= 0.15 micrometers) with this order. They are A:alpha =0 degree and h= 0.01 micrometers more preferably. X:alpha = 5 degrees and h= 0.01 micrometers G:alpha = 5 degrees and h= 0.1 micrometers H:alpha = it exists within limits (a side top is included) surrounded with the quadrilateral which connected four points (0 degree and h= 0.1 micrometers) with this order. In the resist pattern of the T section, by setting alpha and h as such within the limits, a good lift off, good ion milling, etc. can be performed for the first time, and the rate of a defective also becomes less than 20%. The pattern which has such a T form configuration by the single resist conventionally does not exist. In addition, it means that alpha= 0 degree has parallel tangent and substrate front face 122 in the margo inferior 116 of a horizontal bar portion.

[0044] Setting to drawing 1 , the distance W of Point Wo and Point Wi is W= 0.03-3 micrometers preferably. It is W= 0.1-3 micrometers more preferably. It is W= 0.2-1 micrometer still more preferably. By setting W as such a range, the rate of a defective falls further.

[0045] When the height of a resist pattern is set to T in drawing 1 , it is T= 0.3-3 micrometers preferably. It is T= 0.4-2 micrometers more preferably. It is T= 0.4-1 micrometer still more preferably. Even if T is too large and it is too small, formation of the T section becomes difficult. If T is too small, it will stop moreover, being equal to the use as resist covering. Moreover, since the end face of a milling pattern goes to sleep namely, becomes a substrate front face and parallel closely when T uses a too large pattern as resist covering at the time of milling, it is not desirable.

[0046] In drawing 1 , when the angle of the half-line prolonged in the substrate upper part in contact with a vertical bar partial side edge at Point Wi, and a Point Wi to a substrate front face and the half-line prolonged in the direction of the interior of a vertical bar portion in parallel to make is set to beta, beta= 10-160 degrees is beta= 70-110 degrees more

preferably.
[0047] In drawing 1 , when the angle of a substrate front face and the half-line prolonged in the direction which keeps away from a vertical bar portion to parallel to make is set to gamma from the intersection of the half-line which is prolonged and touches a horizontal bar partial side edge in the height of T/3 from a substrate front face from a substrate front face, and a this half-line and a substrate front face, gamma= 60-100-degree gamma= 20-120 degrees are gamma= 80-90 degrees still more preferably more preferably.
[0048] When the maximum width of a horizontal bar portion is set to Hw in drawing 1 , it is Hw=0.1-7micrometer preferably. It is Hw=0.3-3micrometer more preferably.
[0049] the time of setting to Vw width of face of the field in which the vertical bar portion is in contact with the substrate front face in drawing 1 -- desirable -- Vw/Hw=0.1-0.995 -- it is Vw/Hw=0.15-0.95 more preferably
[0050] Usually, although a concave side is made, when Hw is small, as for the upper surface section of the resist pattern of the T section of this invention, there are the shape of a plane or a convex and a bird clapper.
[0051] In addition, when a substrate front face is a field where the vertical bar portion of a resist pattern touches, for example, the resist pattern is formed in front faces, such as a milling-ed film, in this specification, front faces, such as the aforementioned milling-ed film, are substrate front faces.
[0052] As for the quality of the material on the front face of a substrate in which the resist pattern of the T section of this invention is formed, it is desirable that they are metal (alloy is included) material or ceramic material. As a metal simple substance, Cr, aluminum, W, Te, Mo, Fe, nickel, Co, Mn, Ti, Ta, Au, Ag, Cu, etc. can be preferably used among metallic materials. As an alloy, Fe-nickel, nickel-Mn, Fe-nickel-Co, Fe-Co, etc. can be used preferably. as ceramic material -- NiO, aluminum 2O3, and ZrO2 etc. -- carbide, such as multiple oxides, such as an oxide, LiNbO2, LiTaO3, and a ferrite, and AlTiC, etc. can be used preferably In addition, especially these crystallinity is not limited.
[0053] By using the substrate which has the front face of such the quality of the material, the resist pattern of the characteristic cross-section configuration of this invention can be formed. In addition, in this invention, Si single crystal substrate which may set to manufacture of a semiconductor device and is used is not used. According to the experiment of the artificer of this invention, on Si single crystal substrate, even if it uses the above-mentioned resist agent, the resist pattern of the characteristic cross-section configuration of this invention cannot be formed. moreover, a front face -- SiO2 etc. -- since the substrate which consists of silicon oxide as well as Si substrate cannot form the above resist patterns, it is not used by this invention
[0054] Next, the formation method of the resist pattern of the T section of this invention is explained.
[0055] The example of the chemical reaction which occurs the patterning process of a picture reversal correspondence positive resist in drawing 10 in a resist in each of that stage is shown in drawing 11 . This patterning process is explained for every stage (about the detail). M. Spac et al and "Mechanism and lithographic evaluation of image reversal in AZ5214 photoresist.", Proc.of conference on photopolymers principle processing and materials., and Ellenville (1985) It is written. In addition, the following explanation is the things about an example which used the basic amine as a negative working-ized agent.
[0056] (1) The 1st phase The picture reversal correspondence positive resist 2 is applied to the upper surface of the exposure substrate 1, and ultraviolet rays A (wavelength : 300-500nm) are irradiated after prebaking through the mask 3 which has a predetermined pattern on the resist film upper surface (exposure). In the exposure section 4 of a resist 2, a diazo naphthoquinone carries out WORUFU transition and serves as an indene carboxylic acid (formula 1 reference of drawing 11). An indene carboxylic acid serves as an amine salt of an unstable carboxylic acid somewhat according to an acid-alkaline reaction with the basic amine which is a negative working-ized agent (formula 2 reference of drawing 11).
[0057] (2) The 2nd phase Reversal BEKU (RB)
Reversal BEKU of the resist is carried out after the reaction of a formula 2. As for the temperature of reversal **-KU, it is desirable to consider as 90-130 degrees C. By heating by reversal **-KU, the amine salt of a carboxylic acid causes a decarbonylation reaction promptly, and serves as an insoluble indene at an alkaline-water solution (formula 3 reference of drawing 11). An indene is not only insoluble in an alkaline-water solution, but is inactive to subsequent UV irradiation and subsequent heating. Reversal BEKU in this case is usually equivalent to the postbake of a process, and does not need to give a postbake in this process.
[0058] (3) the 3rd phase flood exposure -- here, ultraviolet-rays B irradiation is received, and the diazo naphthoquinone which is the sensitization machine of the unexposed section 5 which was unexposed serves as an indene carboxylic acid meltable in an alkaline-water solution at the time of the first exposure (formula 1 reference), then a resist serves as an amine salt of a carboxylic acid by the reaction with a basic amine (formula 2 reference) The amine salt of this carboxylic acid is also meltable in an alkaline-water solution. Although the wavelength of ultraviolet rays B may be the same as ultraviolet rays A, since ultraviolet rays B is not [pattern formation] related, especially the wavelength is not

limited. In addition, although flood exposure is not necessarily needed, when not using, it is necessary to use a comparatively high-concentration developer and, and there is possibility of generating of the scum in development.
[0059] (4) The 4th phase By developing negatives in alkaline solution at the development last, it melts, only the exposure section 4 remains and patterning completes the unexposed section 5.
[0060] As what is marketed among picture reversal correspondence positive resists, there is resist AZby Hoechst A.G. (Hoechst)5200E series. The detailed property of this resist is shown in M. BORUSEN, "the submicron lithography technology by picture reversal of a positive-type photoresist", electronic material, and 6 and 1 (1986).
[0061] Next, the conditions of each stage when other conditions in the patterning process of a picture reversal correspondence positive resist shown previously are the same show the influence which it has on the cross-section configuration of a resist to drawing 12 , and explain them to it below.
[0062] (1) a substrate front face -- the relation between the patterning conditions of these and the cross-section configuration of the resist obtained is based neither on the quality of the material on the front face of a substrate, nor the existence of substrate surface treatment (HMDS gaseous-phase processing etc.) Preferably, the surface treatment of a substrate has good how to bend.
[0063] (2) If application thickness of the application thickness of a resist, prebaking temperature, and a time resist is made thin, the vena contracta (slit) is formed in the substrate grounding portion of a reverse trapezoid, the width of face of the vena contracta becomes large, and the cross section changes from the reverse trapezoid to T form. Preferably, the application thickness of a resist is 3 micrometers. The following (after prebaking) is good. The minimum of the application thickness of a resist usually has desirable about 0.3-0.5 micrometers. Although prebaking temperature and its time hardly affect the cross-section configuration of a resist, it is [prebaking temperature] desirable to carry out to below reversal baking temperature.
[0064] (3) If light exposure light exposure is reduced, the vena contracta (slit) is formed in the substrate grounding portion of a reverse trapezoid, and the cross section changes from the reverse trapezoid to T form. Although desirable light exposure changed with the kind of exposure machine, wavelength distributions of exposure light {ultraviolet rays, laser beams (excimer etc.), an X-ray, an electron ray, etc. are included}, etc., in the experiment which results in this invention, its 10 - 500 mJ/cm2 was desirable. the case where the wide band light and g line (wavelength of 436nm) of i line (wavelength of 365nm) cut will be used as an exposure light if it explains to a detail more -- desirable -- 100 - 500 mJ/cm2 -- more -- desirable -- 100 - 400 mJ/cm2 and the case where are 100 - 330 mJ/cm2 still more preferably, and i line is used -- desirable -- 10 - 100 mJ/cm2 -- it is 30 - 60 mJ/cm2 more preferably In addition, in order to make the pattern of MR film detailed in a magnetoresistance-effect (MR) type thin film, it is desirable to use the light or the electron ray of wavelength not more than i line or it for exposure light. By the detailed resist pattern formed using i line, the thing of the good T section is not obtained conventionally.
[0065] Moreover, the height of the vena contracta formed in the substrate grounding portion of a resist pattern can be adjusted by controlling the focal position of exposure light. Specifically, if a focal position is moved to a substrate side, the height of the aforementioned vena contracta will become low, and if a focal position is moved to a substrate and an opposite side, the height of the aforementioned vena contracta will become high. When a focal position is displayed by considering as plus the direction which considers as minus the direction which approaches a substrate on the basis of a resist paint film front face, and keeps away from a substrate, -1-+10 micrometers of focal positions are -1-+6 micrometers more preferably. By making a focal position into such a range, it can perform easily making Above h into this invention range.
[0066] (4) If reversal BEKU (RB) temperature and RB time RB temperature are lowered, the vena contracta (slit) will be formed in the substrate grounding portion of a reverse trapezoid, the width of face of the vena contracta becomes large, and the cross section changes from the reverse trapezoid to T form. Especially RB temperature has desirable 100-118 degrees C 100-123 degrees C. Moreover, if it is more than predetermined RB time and RB time will be shortened, the inclination for the vena contracta (slit) to be formed in the substrate grounding portion of a reverse trapezoid, and for a cross section to change from a reverse trapezoid to T form will be promoted. As for this RB time, for [for / 30 seconds / -] 13 minutes is desirable. If RB time is too short, a reaction as shown in drawing 11 will stop in addition, arising.
[0067] (5) although flood light exposure flood light exposure hardly affects the cross-section configuration of a resist -- usually -- 100 - 600 mJ/cm2 ** -- carrying out is desirable
[0068] (6) If development conditions and a rinse condition developer are alkaline solution, they will hardly affect the cross-section configuration of a resist. For example, it is good at phosphate solution, TMAH, etc. The vena contracta (slit) becomes is easy to be formed in such a reverse trapezoid substrate grounding portion that a developing time is so long that the temperature of a developer is high, the width of face of the vena contracta becomes large, and the cross section changes to T form. It is desirable to use 1 - 3% (NanH3-nPO4) solution of phosphate as a developer, as for

development temperature, it is desirable to consider as a room temperature (20-25 degrees C), and, as for a developing time, it is desirable to consider as for 30 - 90 seconds. If a rinse is pure water, it will not be based on the temperature and rinse time of a rinse, and will hardly affect the cross-section configuration of a resist. It is desirable to use ultrapure water as a rinse, as for rinse temperature, it is desirable to consider as a room temperature (20-25 degrees C), and, as for rinse time, it is desirable to consider as for 10 - 180 seconds.

[0069] (7) Although a baking process may be established after after [development] BEKU development for dryness etc., the conditions of BEKU after development hardly affect the cross-section configuration of a resist.

[0070] Thus, the resist pattern with which a cross section has T form at the time of various combination of the conditions of each stage in the patterning process of a picture reversal correspondence positive resist is obtained. That is, when a resist cross section is exposed for example, with the light exposure of under the minimum light exposure used as a reverse trapezoid at the time of the combination of some reversal baking conditions and development conditions, the resist pattern of the T section can be formed. Moreover, when a resist cross section carries out reversal BEKU at the temperature of under the minimum reversal baking temperature used as a reverse trapezoid at the time of the combination of some exposure conditions and development conditions, the resist pattern of the T section can be formed. Although control of light exposure or reversal baking temperature, especially control of reversal baking temperature are effective in this way in order to form the resist pattern of the T section, as described above, the T section of a desirable configuration can be obtained also by controlling other various conditions.

[0071] By using the resist pattern of this invention explained above, a desirable magnetoresistance-effect (MR) type thin film can be obtained.

[0072] An example of the layer structure of the compound-die thin film magnetic head equipped with the magnetoresistance-effect type thin film reproducing head and the inductive mold thin film recording head which are an example of the magnetoresistance-effect type thin film of this invention was shown in drawing 13 . this drawing -- setting -- a sign 10 -- the magnetoresistance-effect type thin film reproducing head and 11 -- for a lower shield layer and 14, as for a magnetoresistance-effect film and 16, an insulator layer and 15 are [a substrate and 12 / an insulator layer and 13 / MR lead layer (electrode layer for magnetoresistance-effect films) and 17] insulator layers And such the magnetoresistance-effect type thin film reproducing head 10 is combined with the inductive mold thin film recording head 20 of the structure known from the former, and let it be the head of a compound die. The inductive mold thin film recording head 20 is usually equipped with the lower magnetic pole 21, an insulator layer 22, the insulator layer 23, the coil 24, the up magnetic pole 25, and the protective layer 26.

[0073] Ceramic material, such as AlTiC, is usually used for a substrate 11.

[0074] an insulator layer 12 -- thickness about 1-20 micrometers -- aluminum 2O3 and SiO2 etc. -- being formed is desirable

[0075] As for the lower shield layer 13, it is desirable to be formed by FeAlSi, NiFe, CoFe, CoFeNi, FeN, FeZrN, FeTaN, CoZrNb, CoZrTa, etc., and its 0.5-3 micrometers are [especially the thickness] desirable 0.1-5 micrometers.

[0076] an insulator layer 14 -- thickness -- 100-2000A a grade -- aluminum 2O3 and SiO2 etc. -- being formed is desirable

[0077] Although the magnetoresistance-effect film 15 may be constituted from one layer of magnetic layers, it is desirable to usually consider as the multilayer structure which carried out the laminating of a magnetic layer and the non-magnetic layer. As a material of a magnetic layer, NiFe, NiFeRh, FeMn, NiMn, Co, Fe and NiO, NiFeCr, etc. are desirable, for example. Moreover, as a material of a non-magnetic layer, Ta, Cu, Ag, etc. are desirable, for example. It is desirable to consider as the structure which repeated and carried out the laminating of the multi-unit by making the three-tiered structure of NiFeRh/Ta/NiFe and two or more layer structures, such as NiFe/Cu/NiFe/FeMn, NiFe/Cu/Co/FeMn, Cu/Co/Cu/NiFe, Fe/Cr, Co/Cu, and Co/Ag, into one unit as the above-mentioned multilayer structure, for example. Furthermore, when considering as such multilayer structure, the thickness of a magnetic layer is 5-500A, especially 10-250A. Carrying out is desirable. The thickness of a non-magnetic layer is 5-500A, especially 10-250A. Carrying out is desirable. Especially the number of repeats of the above-mentioned unit has 1 - 20 desirable times 1 to 30 times. And the thickness of the whole magnetoresistance-effect film is 50-1000A, especially 100-600A. It is desirable.

[0078] For MR lead layer 16, it is desirable to be formed by W, Cu, Au, Ag, Ta, Mo, CoPt, etc., and the thickness is 100-5000A, especially 500-3000A. It is desirable.

[0079] the above-mentioned insulator layer 17 -- aluminum 2O3 and SiO2 etc. -- being formed -- desirable -- the thickness -- 50-5000A -- especially -- 100-2000A It is desirable.

[0080] Insulator layers 12, 14, and 17, the magnetoresistance-effect film 15, and MR lead layer 16 can form milling patterning either the above-mentioned lift-off method or the method among each class which constitutes a magnetoresistance-effect type thin film head using the resist pattern of this invention mentioned above. On the other

hand, the thick lower shield layer 13 of thickness can be formed by the above-mentioned milling patterning method using the resist pattern of this invention mentioned above.

[0081] Moreover, what is necessary is just to use the method of using together the above-mentioned lift-off method and the milling patterning method using the resist pattern of this invention mentioned above, in forming the continuation film of the magnetoresistance-effect film 15 and MR lead layer 16.

[0082] If the resist pattern of this invention is used, it is efficient and, moreover, the above magnetoresistance-effect type thin film heads can be manufactured with the sufficient yield.

[0083]

[Example] Hereafter, the concrete example of this invention is explained.

[0084] In the example explained below, resist AZ5214E (that whose solid-content content it is the resist a basic amine is added as a negative working-ized agent by the positive resist containing the mixture of alkali fusibility phenol resin and naphthoquinonediazide, and using propylene-glycol-monomethyl-ether acetate as a main solvent, and is 28.3%) was used as a picture reversal correspondence positive resist.

[0085] Resist pattern sample No.1-8 shown in the <example 1> table 2 were produced. The production conditions of each sample are shown in Table 1 and 2. The light exposure, the focal position, and RB temperature which change conditions common to all samples with samples in Table 2 are shown in Table 1. It produced each 1000 samples at a time so that it might enter within the limits of each production condition.

[0086]

[Table 1]

表　1

基板	：表面にＡｌ２Ｏ３層を設けたＡｌＴｉＣ
基板表面処理	：なし
レジスト	：ヘキスト（Hoechst）社製ＡＺ５２１４Ｅ
レジスト膜厚	：約１．８μｍ（プリベーク後）
プリベーク温度、時間	：９５℃、６分間（ダイレクトホットプレート）
露光機	：ステッパー（ウルトラテック（Ultratech）社製、Ultrastep Model 1500） ＮＡ＝０．２８、焦点位置（表２に示す） ＵＶ：広域幅（ｉ線カット）
露光量	：表２に示す（マスク幅：２．０μｍ）
ＲＢ温度	：表２に示す（ホットプレート）
ＲＢ時間	：５分間
フラッド露光機	：ＰＬＡ（パラレルライトアライナー）（キヤノン（Canon）社製ＰＬＡ－５０１Ｆ）
フラッド露光量	：５００ｍＪ／ｃｍ２
現像液、温度、時間	：シプレー（Shipley）社製、マイクロ　ポジット　デベロッパ（Micro Posit Developer） （：Ｈ２Ｏ＝１：１）、２３℃、７０秒間（パドル：水たまり状の現像液に接触させて現像）
リンス液、温度、時間	：超純水、２３℃、６０秒間（パドル）
現像後ベーク	：なし

[0087]

[Table 2]

表 2

サンプル No.	露光量 (mJ/cm²)	焦点位置 (μm)	RB温度 (℃)	α (°)	h (μm)	不良品率 (外観検査および電磁変換特性によるもの)
1 (比較)	100～330	-10～-4未満	100～118未満	0～5未満	0～0.01未満*	40%以上
2	100～330	-4～-1未満	100～118未満	0～5未満	0.01～0.03未満	20%以上40%未満
3	100～330	-1～+6未満	100～118未満	0～5未満	0.03～0.1	10%未満
4	100～330	+6～+10	100～118未満	0～5未満	0.1超～0.2	10%以上20%未満
5 (比較)	100～330	+10超	100～118未満	2.5超～5未満	0.3超*	40%以上
6	330～400	-1～+6未満	118～123未満	5超～20	0.03～0.1	10%以上20%未満
7	330～400	+6～+10	118～123未満	5超～20	0.1～0.2	10%以上20%未満
8 (比較)	500	-10～-4未満	130	20超*	0～0.01未満*	40%以上

*)本発明範囲外

[0088] About these samples, Above alpha and h was measured using the Hitachi field emission electron beam formula SEM (Hitachi ULSI highly precise appearance size evaluation equipment S-7000). These results were shown in the above-mentioned table 2. Moreover, when Above W, T, beta, gamma, Hw, and Vw was measured about sample No.3, for about 1.8 micrometers and beta, about 135 degrees and gamma were [W / about 0.75 micrometers and T / about 2.4 micrometers and Vw/Hw of about 90 degrees and Hw] about 0.3. In addition, the equivalent result was obtained as a result of performing measurement with the same said of other samples.

[0089] Moreover, the photograph of sample No.3 cross section photoed using Above SEM was shown in drawing 14 . The resist pattern of the T section of good contrast is obtained so that this photograph may show. In addition, easy Si substrate (thing in which the aluminum2 O3 layer was formed on the front face) of cutting was used for formation of the resist pattern shown in drawing 14 .

[0090] Moreover, each above-mentioned sample is aluminum 2O3 (although the substrate itself is AlTiC) which is a metallic oxide. a substrate front face -- aluminum 2O3 it is, although formed upwards Fe-nickel which is nickel, Cr, Ta, and the alloy which are a metal about a substrate front face, Fe-nickel-Co and LiNbO3 which is a compound metallic oxide The place which carried out and formed the resist pattern like above-mentioned sample No.3 except this, It was checked that a value almost equivalent to the value of alpha of Table 2 and h is acquired, and the resist pattern of the T section of good contrast is obtained also in this case.

[0091] The following experiments were conducted in order to investigate the effect when performing milling patterning using the resist pattern of each sample.
[0092] It is aluminum 2O3 to a front face. On the front face of the AlTiC substrate which has a film, NiFe of 0.06 micrometers of thickness was uniformly formed by the spatter. Subsequently, it produced the 1000 magnetoresistance-effect type thin film magnetic heads at a time about each sample using the lift-off method (the following was carried out about conditions), the milling patterning method (the following was carried out about ion milling conditions), and the using [together] method (the following was carried out about conditions) which make a mask pattern the resist pattern of above-mentioned sample No.1-8, respectively. The lamination of these magnetic heads shall be shown in drawing 13 .
[0093] lift-off condition organic-solvent: -- acetone organic-solvent immersing time: -- for 30 minutes -- [0094] kind [of ion milling condition ion]: -- Ar+ gas pressure: -- 1.5x10-1Torr acceleration voltage: -- 300V acceleration current: -- 250mA milling angle: -- 90 degrees (as opposed to a substrate front face)
Time: 8 minutes [0095] Combined use with the using [together] method condition above-mentioned ion milling conditions and lift-off conditions [0096] the obtained magnetoresistance-effect type thin film magnetic head -- visual inspection and electromagnetism -- the rate of a defective based on the transfer characteristic was investigated The result was shown in the above-mentioned table 2. The magnetic head by which alpha and h were produced from the above-mentioned table 2 using this invention sample in the predetermined range is understood that the rate of a defective is remarkably low.
[0097] In addition, on the occasion of production of these magnetic heads, the shield layer was formed by the milling patterning method among each class shown in drawing 13 , and the continuation film of a magnetoresistance-effect film and the electrode layer for magnetoresistance-effect films was formed by the using [together] method. However, the equivalent result was obtained, even when a magnetoresistance-effect film was formed by the milling patterning method and the electrode layer for magnetoresistance-effect films was formed by the lift-off method.
[0098] The resist pattern sample was produced on the conditions shown in the <example 2> following table 3.
[0099]
[Table 3]

表　3

基板	：表面にＡｌ$_2$Ｏ$_3$層を設けたＳｉ
基板表面処理	：なし
レジスト	：ヘキスト（Hoechst）社製ＡＺ５２０６Ｅ
レジスト膜厚	：約０．７μｍ（プリベーク後）
プリベーク温度、時間	：９５℃、６分間（ダイレクトホットプレート）
露光機	：ステッパー（キヤノン（Canon）社製、FPA-3000i4） ＮＡ＝０．４５、焦点位置＝±０．００μｍ ＵＶ：ｉ線
露光量	：５０ｍＪ／ｃｍ^2（マスク幅：０．５５μｍ）
ＲＢ温度	：１１３℃（ホットプレート）
ＲＢ時間	：３分間
フラッド露光機	：ＰＬＡ（パラレルライトアライナー）（キヤノン（Canon）社製ＰＬＡ－５０１Ｆ）
フラッド露光量	：２００ｍＪ／ｃｍ^2
現像液、温度、時間	：シプレー（Shipley）社製、マイクロ　ポジット　デベロッパ（Micro Posit Developer） （４０％水溶液）、２３℃、５０秒間（パドル：水たまり状に現像液を接触させて現像）
リンス液、温度、時間	：超純水、２３℃、６０秒間（パドル）
現像後ベーク	：なし

[0100] the place which measured the cross section of this sample by Above SEM like the example 1 -- alpha -- about 0 degree and h -- for about 0.5 micrometers and beta, about 80 degrees and gamma were [about 0.02 micrometers and W / about 0.26 micrometers and T / about 0.65 micrometers and Vw/Hw of about 70 degrees and Hw] about 0.21
[0101] The SEM photograph of this sample is shown in drawing 15 .
[0102] The following experiments were conducted in order to investigate the effect when performing membranous patterning using this resist pattern sample.
[0103] It is aluminum 2O3 to a front face. On the front face of the AlTiC substrate which has a film, the

magnetoresistance-effect film (MR film) of multilayer structure was formed by the spatter. Composition and thickness of MR film are NiFeRh/Ta/NiFe/Ta=130/100/200/50 (A).
It carried out. Subsequently, the above-mentioned resist pattern sample was prepared as resist covering on MR film, and patterning was performed by the milling method. Then, without removing resist covering, the electrode layer for magnetoresistance-effect films of multilayer structure (MR lead layer) was formed by the lift-off method, and the continuation film of MR film and MR lead layer was obtained. Composition and thickness of MR lead layer are TiW/CoPt/TiW/Ta=100/500/100/1000 (A).
It carried out. The photograph of this continuation film by Above SEM is shown in drawing 16 . In this continuation film, the width of face (width of recording track at the time of applying to the magnetic head) of MR film was 0.36 micrometers.
[0104] When the 1000 magnetoresistance-effect type thin film magnetic heads were produced like this method and the rate of a defective was investigated like the example 1, it was 10% or less. According to this invention, this result shows that it is stabilized and the magnetoresistance-effect type thin film magnetic head of the ** width of recording track can be manufactured.
[0105]
[Effect of the Invention]
(A) An one-layer resist can also form now easily the resist pattern with which the cross section has T form with contrast by controlling conventionally the conditions of patterning process in which only the reverse trapezoid was obtained, according to this invention.
[0106] (B) The width of face of the T section of a resist pattern, the width of face (Vw in drawing 1) of a substrate grounding portion, the width of face (W in drawing 1) of the vena contracta in a substrate grounding portion, and vena-contracta height are controllable in a certain amount of range with sufficient repeatability.
[0107] (C) when making into the mask pattern at the time of a lift off or dry etching the resist pattern of the T section which carried out patterning according to this invention, since the cross-section configuration of a mask pattern can be optimized according to thickness, its patterning width of face, etc. of a patterning-ed film, the yield which it is in the case of a lift off or dry etching improves according to the effect of the aforementioned (B) term
[0108] (D) The width of face of a resist pattern cross section is 1 micrometer. The following patterns can also be formed. Thereby, width of face is 1 micrometer. Formation of the following lift-off patterns and a dry etching pattern can be performed.
[0109] (E) Since the resist pattern with which the cross section carried out T form is obtained and it is not necessary to use an expensive facility of an excimer laser etc. by exposure by ultraviolet rays, an installation cost is cheap and ends.
[0110] (F) Although there was need, such as doing the exposure work and the wet development work which need the alignment of a mask two or more times, and it was very complicated in order to form the resist pattern of the T section conventionally, in this invention, since exposure work and development work can be managed at once, respectively, patterning work becomes easy, and shortening of working hours can be aimed at.
[0111] (G) According to the effect of the aforementioned (E) term and the (F) term, a lift-off pattern and a dry etching pattern can be formed cheaply.

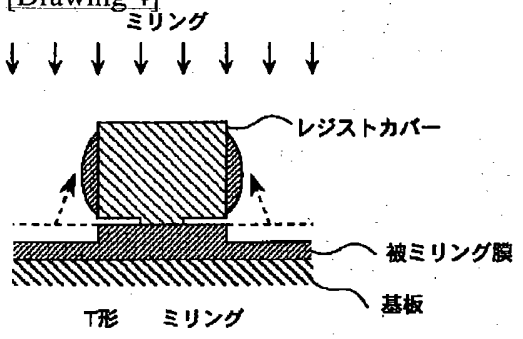
[Translation done.]

* NOTICES *

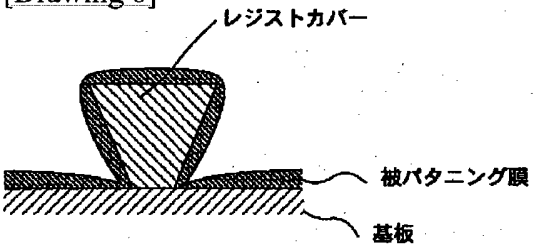
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

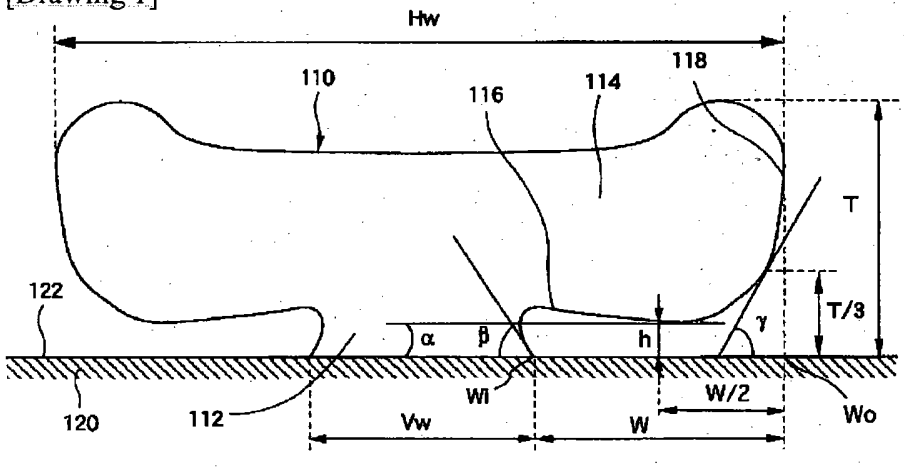
[Drawing 4]



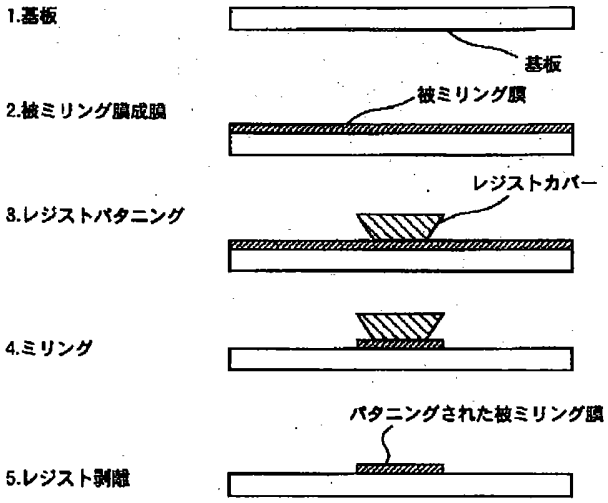
[Drawing 6]



[Drawing 1]

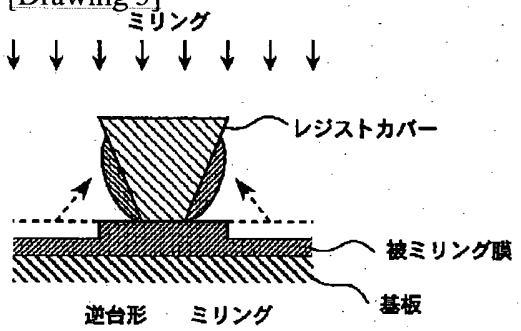


[Drawing 2]

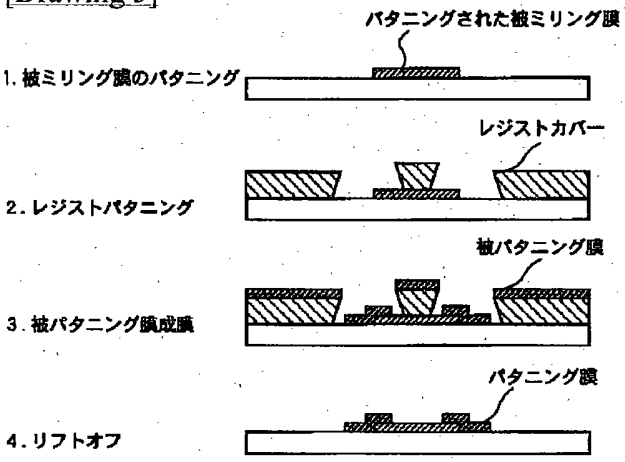


ミリング工程

[Drawing 3]

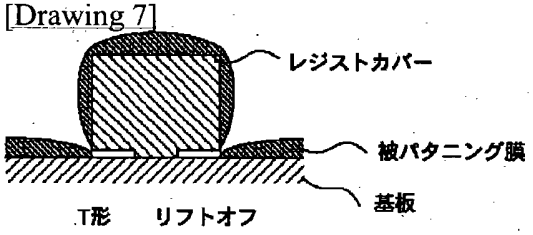


[Drawing 5]

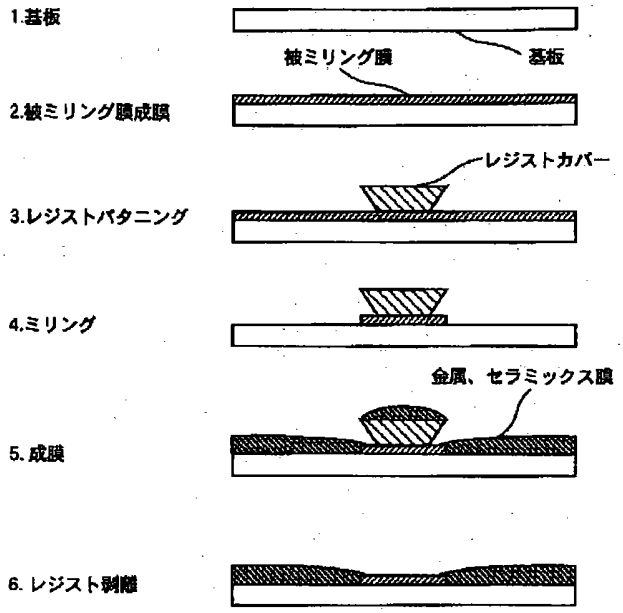


リフトオフ工程

[Drawing 7]

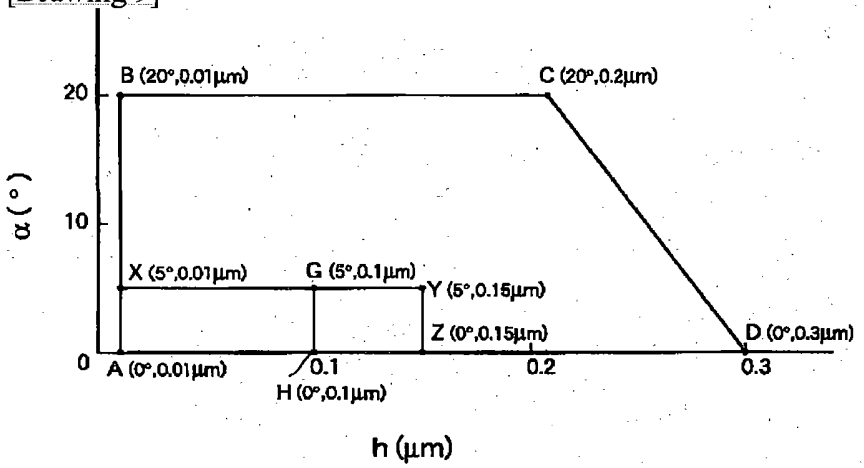


[Drawing 8]

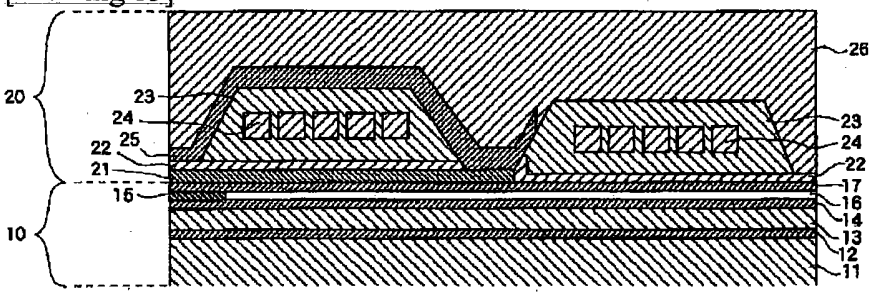


ミリング+リフトオフ工程

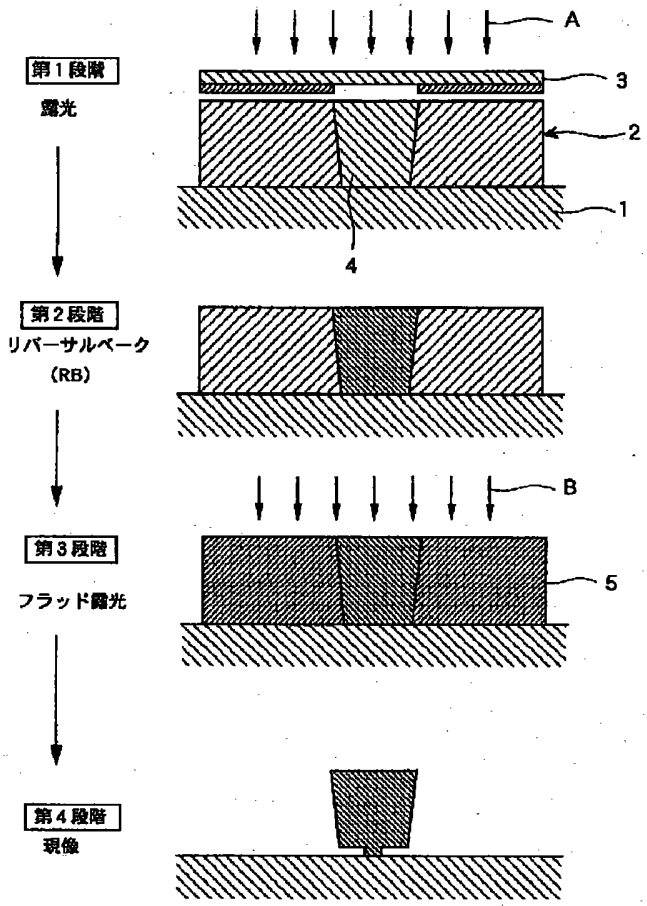
[Drawing 9]



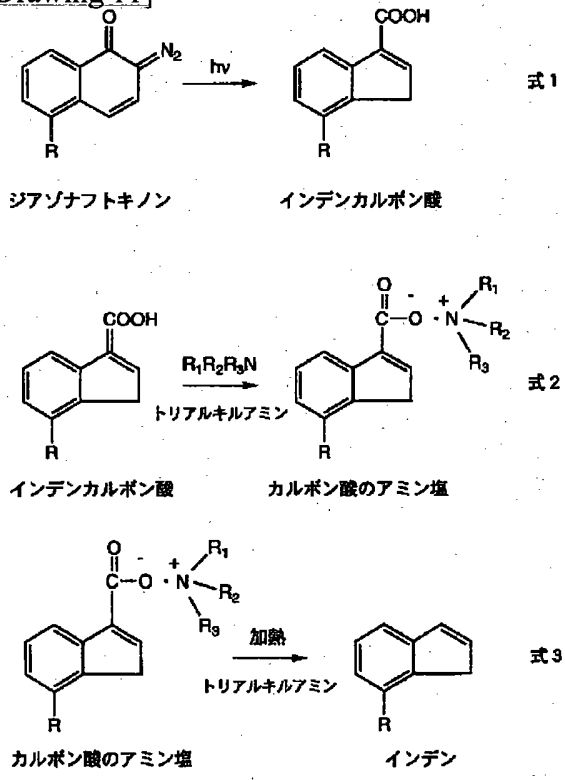
[Drawing 13]



[Drawing 10]

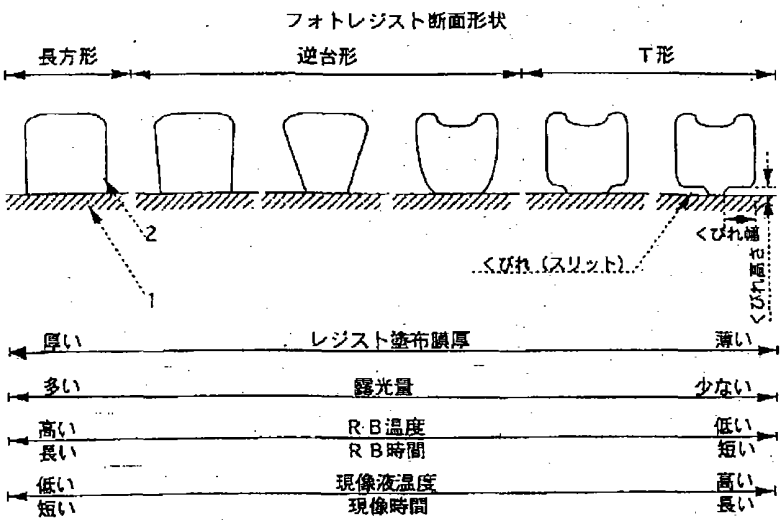


[Drawing 11]



画像反転対応ポジ型レジストのパタニング過程において
レジスト中で起こる化学反応の例

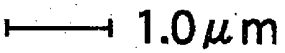
[Drawing 12]



画像反転対応ポジ型レジストのパタニング過程における他の条件が
同一のときの各段階の条件がレジストの断面形状に与える影響

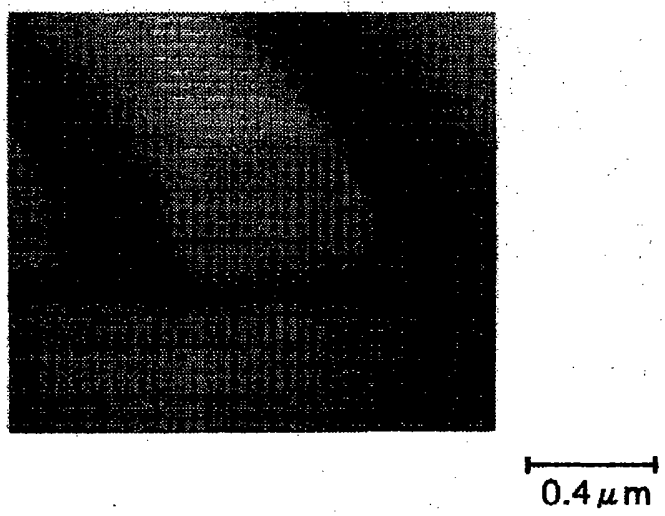
[Drawing 14]

図面代用写真



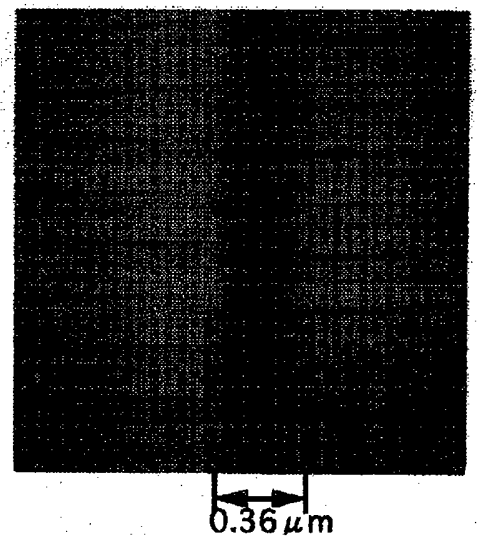
[Drawing 15]

図面代用写真



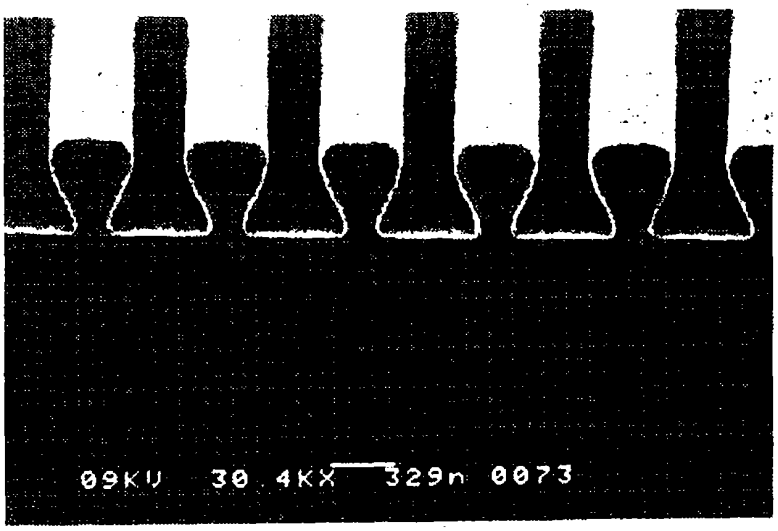
[Drawing 16]

図面代用写真



[Drawing 17]

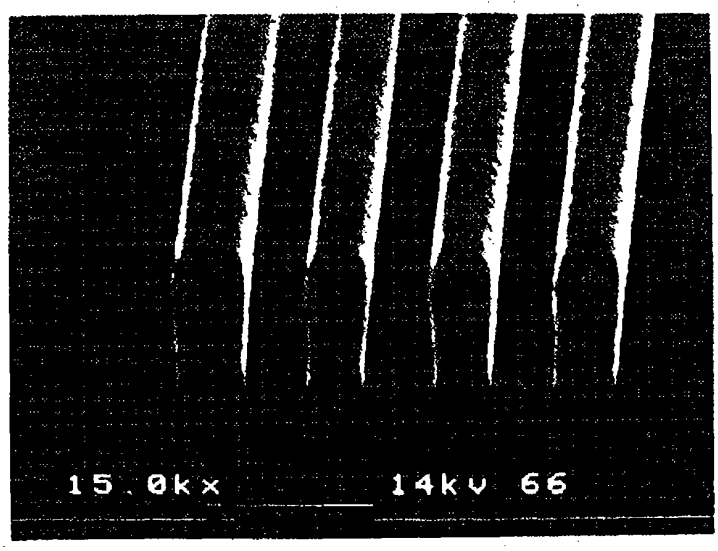
図面代用写真



0.5μm

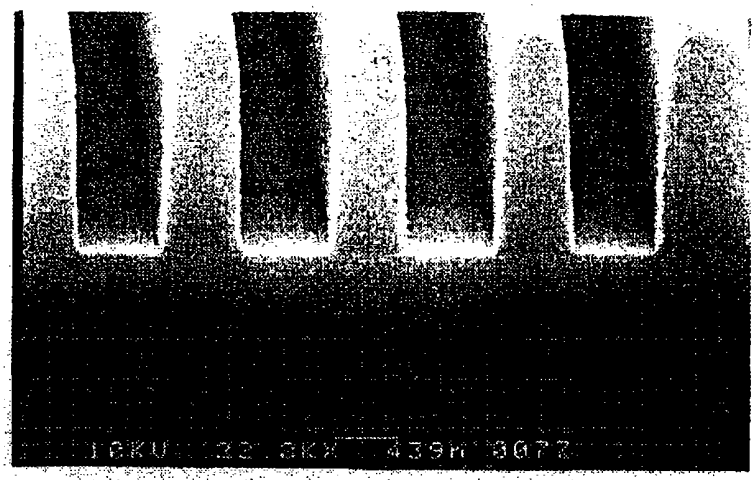
[Drawing 18]

図面代用写真



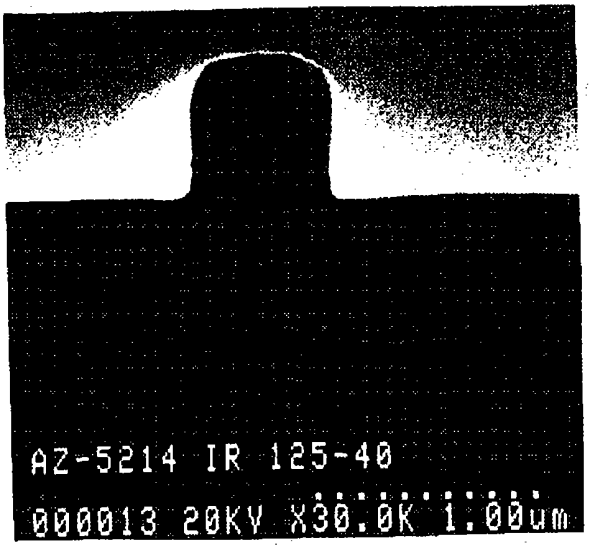
[Drawing 19]

図面代用写真



[Drawing 20]

図面代用写真



[Translation done.]